CEBAF EXPERIMENT 01-011

Spectroscopic study of Λ hypernuclei up to medium-heavy mass region using the (e,e'K^+) reaction

Spokespersons : O. Hashimoto(Tohoku), L. Tang(Hampton), J. Reinhold(FIU)

The aim of the experiment is to investigate a hypernucleus, a hadron many-body system with a strangeness degree of freedom, taking full advantages of a high-quality high-intensity electron beam at CEBAF. A hypernucleus contains a hyperon implanted as an "strange impurity" within the nuclear medium. With the new quantum number, it will not experience Pauli-blocking, easily interacting with deeply bound nucleons. In this sense, the hyperon can be a good probe of the interior of a nucleus, where information is difficult to obtain by ordinary means.

In the E01-011 experiment, we intend to extract the characteristics of a Λ hyperon embedded in a nucleus by observing the spectroscopy of its states through the (e,e'K^+) reaction. Such experimental investigation has been conducted mostly by meson beams so far.

Spectroscopic study of Λ hypernuclei by the (e,e'K^+) reaction has unique advantages over those by meson-induced reactions such as (π^+, K^+) and (K^-, π). Contrary to the meson-induced reactions, the (e,e'K^+) reaction favorably excites spin-flipped Λ hypernuclear states and produces neutron-rich Λ hypernuclei converting a proton to a Λ hyperon, by which new aspects of the hypernuclear system are to be studied. From the experimental point of view, it is also of significant importance that the reaction allows us to improve the energy resolution down to a few 100 keV thanks to the high-quality electron beam at CEBAF.

A pioneering E89-009 experiment already demonstrated a great potential of the (e,e'K^+) reaction, obtaining a hypernuclear mass spectrum with the energy resolution of about 600 keV (FWHM) in the ^{12}C(e,e'K^+)$^{12}_{\Lambda}$B reaction. The E01-011 experiment will upgrade the (e,e'K^+) spectroscopy by taking a new experimetnal configuration with so-called "tilt method" and constructing a new high-resolution large-acceptance kaon spectrometer. The energy resolution will be twice better (3-400 keV(FWHM)), the hypernuclear yield more than a order of magnitude greater, and signal-to-accidental ratio about an order of magnitude improved. The proposed experiment has two immediate goals,

1. Measurement of a high-quality excitation spectrum in the ^{28}Si(e,e'K^+)$^{28}_{\Lambda}$Al reaction.

   The spectrum will provides information on the depth of the central potential and possible spin-orbit splittings beyond the p-shell region. The mass dependence of the single-particle levels can be directly compared to calculations using single particle potentials and mean-field theory. Since *p*-shell orbitals are barely bound in *p*-shell hypernuclei, it is essential to extend this measurement beyond the *p*-shell region. The new hypernuclear structures and/or spin-orbit splittings suggested by the recent (π^+,K^+) reaction spectrum in the medium-heavy hypernuclei are to be fully investigated with unprecedented energy resolution.

2. Precision measurement of ^{12}C(e,e'K^+)$^{12}_{\Lambda}$B

   The structure of a typical *p*-shell Λ hypernucleus will be investigated in a qualitative way. This should clearly separate the controversial core excited states, which were observed in the ^{12}C(π^+,K^+)$^{12}_{\Lambda}$C reaction. A high-precision high-statistics study will offer reliable information on inter-shell mixing. Furthermore, the precision spectrum of $^{12}_{\Lambda}$B can be compared to its the mirror symmetric hypernuclei, $^{12}_{\Lambda}$C, which was studied with high statistics but limited resolution by the (π^+,K^+) reaction.

***** Collaborators *****

O. Hashimoto (Spokesperson)*, S.N. Nakamura, Y. Fujii, H. Tamura, T. Takahashi, K. Maeda, H. Kanda, T. Miyoshi, H. Yamaguti, Y. Okayasu, K. Tsukada

Department of Physics, Tohoku University, Sendai, 980-8578, Japan

S. Kato

Department of Physics, Yamagata University, Yamagata, 990-8560, Japan

H. Noumi

Institute for Particle and Nuclear Physics, KEK, Tsukuba, 305-0801, Japan

T. Motoba

Laboratory of Physics, Osaka Electro-Communication University, Neyagawa, 572-8530, Japan

L. Tang (Spokesperson), O.K. Baker, L. Cole, M. Christy, L. Gan, A. Gasparian, P. Gueye, B. Hu, C. Jackson, C. Keppel, Y. Sato, A. Uzzle, L. Yuan, X.F. Zhu

Department of Physics, Hampton University, Hampton, VA 23668, USA

J. Reinhold (Spokesperson), P. Markowiz

Department of Physics, Florida International University, Miami, FL 27411 USA

Ed. V. Hungerford, K. Lan, G.H. Xu

Department of Physics, University of Houston, Houston, TX 77204 USA

R. Carlini, R. Ent, H. Fenker, K. Garrow, D. Mack, G. Smith, W. Vulcan, S. Wood, C. Yan

Thomas Jefferson National Accelerator Facility, Newport News, VA 23606 USA

A. Ahmidouch, S. Danagoulian

Department of Physics, North Carolina A& T State University, Greensboro, NC 27411 USA

D. Dehnhard, H. Jungust, J. Liu

Department of Physics, University of Minnesota, Minnesota, USA

N. Simicevic, S. Wells

Department of Physics, Louisiana Tech University, Ruston, LA USA

M. Elaasar

Department of Physics, Southern University at New Orleans, New Orleans, Louisiana, USA

R. Asaturyan, H. Mkrtchyan, A. Margaryan, S. Stepanyan, V. Tadevosyan

Yerevan Physics Institute, Armenia

D. Androic, M. Planinic, M. Furic

Department of Physics, University of Zagreb, Croatia

T. Angelescu

Department of Physics, University of Bucharest, Bucharest, Romania
V. P. Likhachev

Department of Physics, University of Sao Paulo, Sao Paulo, Brasil